A Pilot Study to Explore the Correlation Between Parental Nutrition Literacy, Child Healthy Eating Index-2010 and Weight Status

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A Pilot Study to Explore the Correlation Between Parental Nutrition Literacy, BMI and Child Healthy Eating Index-2010

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Abstract

Objective: Improving diet quality and weight status of children and parents is important for promoting future health. The purpose of this study was to investigate parental nutrition literacy (PNL) in relation to child Healthy Eating Index-2010 (HEI) and parental body mass index (BMI).

Design, Setting, and Participants: Forty-six parents of children aged 4-6 years consented to this cross sectional study. PNL was assessed using the Nutrition Literacy Assessment Instrument for Parents (NLAI-P) that contains 42 questions relating to 5 domains of nutrition literacy. Child HEI was determined from the average of two 24-hour dietary recalls. BMI was calculated with measured height and weight.

Outcome Measures and Analysis: Parental NLAI-P was scored as a combined percent correct. The relationship among parental BMI, parental NLAI-P score, child BMI percentile for age and child HEI were measured by Spearman correlations and linear regression.

Results: Average NLAI-P score was 83.6% (range=64.2-97.6; SD=8.7). Average child HEI was 53.5 (range=31-86; SD=14.1). Child HEI was related to parental NLAI-P score ($r=0.324$, $p=0.03$). Parental BMI, not child BMI percentile for age, had a significant inverse relationship with parental NLAI-P score ($r=-0.456$, $p=0.001$). There was a linear relationship between parental BMI and NLAI-P score ($R^2=0.157$; $p=0.004$). For every 1% increase in parental NLAI-P score, BMI decreased by 0.26.

Conclusions and Implications: This is the first investigation into measured PNL in relation to weight status and child diet quality. Results suggest that lower PNL may be a

barrier for parents to build a healthful diet for their child. Larger population studies are needed to confirm this relationship

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Chapter 1: Justification

Health literacy is defined by the Institute of Medicine as "the degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions" (1). A 2011 literature review revealed that individuals with inadequate health literacy may experience disparities in health such as higher hospitalization rates, increased use of emergency health services, higher rates of medication administration errors, difficulty interpreting medication and nutrition labels, lower quality of health and higher mortality rates in older adults (2). In addition, individuals with low health literacy may have difficulty managing chronic diseases such as diabetes (3-5), heart failure (6, 7), and chronic kidney disease (8, 9).

Health literacy among parents in the United States varies (10). The National Assessment of Adult Literacy includes health related questions and categorizes those that complete the assessment as either "below basic," "basic," "intermediate," or "proficient" health literacy (11). The 2003 National Assessment of Adult Literacy found that approximately 84% of parents had below proficient health literacy (10). Parents have the responsibility of making their own health decisions as well as making health decisions for their children. Inadequate parental health literacy may be a barrier in providing adequate medical care to children. Lower parental health literacy has been associated with pediatric health outcomes such as poorer control of asthma symptoms and emergency department visits (12), glycemic control (13), improper medication dosing (14), and non-participation from the parent in decision-making for the child's medical care (15). Other studies have disputed these findings, reporting no significant difference in glycemic

control (16), asthma symptoms (17), emergency department visits (18, 19), medication dosing (20) or following the recommended time table for immunizations (21).

More recently the topic of health literacy has emerged into the nutrition literature. Nutrition literacy is defined as "the degree to which individuals have the capacity to obtain, process and understand basic nutrition information" (22). Two recent review articles identified the need for more research specific to nutrition literacy (23, 24).

Children have unique dietary needs and in recent years there has been an increase in nutrition related health issues in the pediatric population. This may imply that inadequate parental nutrition literacy is an issue. Past research has focused on parental health literacy and nutrition related outcomes such as glycemic control (13, 16), childhood obesity (25-28), dental carries (29-31), and nutrition related behaviors (27). To date there has not been research that has evaluated parental nutrition literacy in relation to pediatric dietary quality and weight status.

The primary purpose of this study will be to evaluate parental nutrition literacy in relation to child diet quality and weight status; the secondary purpose of this study is to establish scoring criteria for the Nutrition Literacy Assessment Instrument for Parents (NALI-P). Because parents are responsible for making nutrition decisions for themselves as well as their children, it is expected that a child whose parent scores lower on the NLAI-P will have a lower healthy eating index score (HEI-2010) and higher body mass index percentile for age (BMI).

Chapter 2: Review of Literature

Health literacy is defined by the Institute of Medicine as "the degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions" (1). Since the Institute of Medicine executive summary of health literacy was published in 2004, there has been a growing body of literature on the topic and how it relates to health outcomes. More recently, the topic of health literacy has emerged into nutrition literature and the call has been made for additional research on the topic of nutrition literacy (23, 24).

The purpose of this literature review is to examine research specific to parental health literacy and the association with pediatric nutritional status. Articles discussed in this review are limited to those that either used a validated measure of health literacy, numeracy or a generally accepted measure of nutrition literacy. Search terms of parental health literacy, parental nutrition literacy, children and health knowledge were used to identify relevant research articles. Because parents are responsible for making health and nutrition decisions for both themselves and for their children, it would be expected that parents with lower health and nutrition literacy have children with moderately lower nutrition status compared to parents with higher health and nutrition literacy.

Background

The National Assessment of Adult Literacy identified four levels of health literacy (11). It is estimated that 14% of people in the United States have "below basic" literacy, this is

defined as a person having “no more than the most single and concrete literacy skills” (11). Individuals with below basic health literacy can only complete simple tasks such as identifying dates for medical appointments or following basic instructions before a medical procedure (11). “Basic” health literacy has been observed in 22% of people in the United States, basic literacy is defined as having the “skills necessary to perform simple and everyday literacy activities” (11). Individuals with basic health literacy can only comprehend basic health related written text (11). “Intermediate” literacy is defined as having “skills necessary to perform moderately challenging literacy activities.” Intermediate literacy is seen in 53% of American adults and is described as having the ability to utilize moderately complex health information to complete tasks such as determining a healthy weight range or identifying drug-nutrient interactions. “Proficient” literacy is defined as having “skills necessary to perform more complex and challenging literacy activities,” this level of health literacy has been observed in 12% of American adults (11). Examples of proficient health literacy include having the ability to calculate health insurance costs and utilizing medical legal documents (11). This distribution of health literacy levels indicates that to some magnitude, the majority of the American population lacks skills necessary to make appropriate health decisions.

In the adult population low health literacy has been associated with disparities in health outcomes. A 2011 review of the literature on adult health literacy described the correlation between inadequate health literacy and higher hospitalization rates, usage of emergency health services, higher rates of medication administration errors, difficulty interpreting medication and nutrition labels, lower quality of health and higher mortality

rates in older adults (2). At the time of this review, researchers concluded that there was inadequate evidence to draw conclusions regarding health literacy's impact on chronic disease management (2). Since 2011, more research has been published that investigates how health literacy plays a role in a patient's ability to manage the care of chronic disease such as diabetes (3-5), heart failure (6, 7) and chronic kidney disease (8, 9).

In addition to assessments of health literacy levels in the general American population (11), health literacy has also been investigated within a population of American parents (10). The 2003 National Assessment of Adult Literacy found that 11% of parents have "below basic" health literacy, 17% have "basic" health literacy, 56% have "intermediate" health literacy and 15% have "proficient" health literacy (10). Although these percentages are slightly better than the general population, it suggests that the majority of parents have difficulty making health decisions, a challenge that may impact the health of their children. Factors that are associated with lower parental health literacy include below high school education, non-English speaking, low-income household or ethnicities of African American or Hispanic (10).

A limited number of studies have investigated child health outcomes associated with low parental health literacy. Lower parental health literacy has been associated with pediatric health outcomes such as poorer control of asthma symptoms and emergency department visits (12), glycemic control (13), improper medication dosing (14), and the parent not participating in decisions for child medical care (15). Other studies have disputed these findings reporting no significant difference in glycemic control (16), asthma symptoms

(17), emergency department visits (18, 19), medication dosing (20), or following the recommended time table for immunizations (21). Review articles on parental health literacy and pediatric health outcomes have stated that more research is needed to draw a direct relationship between parental health literacy and pediatric health outcomes (32-35).

Overall, health literacy is a mediator between a patient's understanding of health and their ability to manage their medical care (1). This relationship may also be a factor in a parent's ability to manage their child's medical care. Due to these findings, both healthcare organizations and public health departments have established the need to improve health literacy and to develop communication methods to reduce the negative impact of low health literacy. The Institute of Medicine, American Medical Association and the Joint Commission have made recommendations regarding health literacy and provider-patient communication in order to protect patient safety (1, 36, 37). Improving the rate of adequate health literacy was established as an objective in Healthy People 2010 and is a current objective of Healthy People 2020 (38, 39).

Nutrition Literacy

Health literacy may also have an impact on nutritional status. In 2009 Zoellner et al. defined nutrition literacy as "the degree to which people have the capacity to obtain, process, and understand basic nutrition information" (22). Two review articles on the relationship between health literacy and nutrition emphasized the need for more research within the nutrition literature on nutrition literacy (23, 24). Although there is currently no validated gold standard measure of nutrition literacy, progress has recently been made to

develop a measure (40). There has been an increase in nutrition related health issues being diagnosed at younger ages, including obesity (41), type 2 diabetes (42) and dental caries (43). This may imply that inadequate nutrition literacy is an issue.

Children have unique dietary needs in order to support a healthful growth pattern (44). However, the diets for many children do not demonstrate dietary recommendations as described by the US Dietary Guidelines or meet the Institute of Medicine's recommended amounts for nutrients such as fiber, vitamin D, iron, and calcium (44, 45). Considering that there has been an increase in nutrition related health issues in the pediatric population, along with inadequacies in parental health literacy, improving health and nutrition literacy may be an important issue for preventing the progression of disease into adulthood.

Health Literacy and Obesity

Obesity has become a major health concern, leading to the American Medical Association's recent decision to classify obesity as a disease instead of a health condition (46). Childhood obesity, measured by body mass index (BMI) growth chart percentile, has also become a growing public health concern, especially for males age 2 to 19 years old (41). In 2010 it was estimated that 16.9% of children were considered obese (41). To complicate the issue of childhood obesity, inaccurate assessment of pediatric weight status is a common problem for parents (25, 47). Knowledge of energy density of food, recommended physical activity level and estimated energy needs for children is necessary for the prevention and treatment of obesity.

Four cross-sectional studies were identified that discussed pediatric weight status in relation to parental health or nutrition and physical activity knowledge (26-28, 48). Three studies investigated this relationship in children ranging in age from 6-19 years old with both the parent and the child taking the instrument to measure literacy levels. One study measured health literacy in parents of infants.

Neither parental knowledge of nutrition and physical activity (27) or parental health literacy, measured by the Short Test of Functional Health Literacy (STOFHLA) (26) or Newest Vital Sign (NVS) (48), were associated with elevated adolescent BMI. In addition to measuring parental literacy, these three studies also had adolescent children complete the literacy assessment instrument. STOFHLA score was inversely associated with adolescent BMI ($r= -0.37$, $p=0.0009$) (26) and adolescents who scored in the lowest category of NVS had a higher odds ratio of obesity (AOR = 5.26; 1.26, 22.01 $p= 0.02$) (48). In contrast, there was not a statistically significant relationship between adolescent nutrition and physical activity knowledge (27). The measure of nutrition and physical activity knowledge was limited to a survey on energy expenditure and daily energy requirements for children, and this measure has not been validated in comparison to other measures of health or nutrition literacy (27).

Two studies investigated parental health literacy in infants and younger children. In a population of Hispanic children under 30 months old, Ciampia et al. found that parental health literacy measured by STOFHLA was not associated with child weight-for-length

Z-score (28). In children aged 7-11 years old, Chari et al. found that parental health literacy measured by NVS did not reach a level of statistical significance in unadjusted analysis, but in adjusted analysis parents with lower NVS score had children with a higher odds of obesity (0.75; 0.56, 1.00 p = 0.05) (48).

In addition to this body of research, two other articles were identified that investigated parental health or nutrition literacy in relation to factors that are associated with childhood obesity. Garrett-Wright et al. showed that inaccurate perception of child weight status is slightly more common in parents with low health literacy measured by STOFHLA (OR = 0.98, p=0.006) (25). One article was identified that evaluated nutrition literacy of parents of obese children (49). The majority of parents (90.5%) could correctly place foods into the appropriate food group, while fewer parents (66.7%) could correctly place foods into the appropriate nutrient group (49).

Health Literacy and Diabetes Mellitus

With the increase in childhood obesity, the risk of type 2 diabetes mellitus has become a growing concern in children. Liese and colleagues estimated the prevalence of type 2 diabetes in children aged 10-19 years old to be 0.42 cases per 1000 youth (42). The prevalence of type 1 diabetes is estimated at 1.54 cases per 1000 youth (42). Both types of diabetes mellitus require adequate nutrition knowledge, especially carbohydrate content of food, to promote diabetes management.

Four cross sectional studies were identified that evaluated parental health literacy and pediatric glycemic control (13, 16, 50, 51). Two of these studies used STOFHLA to measure parental health literacy and did not find a significant relationship with adolescent glycemic control (16, 51). In contrast, Hassan et al. utilized NVS and found that low parental health literacy was significantly associated with poorer glycemic control measured by hemoglobin A1c (Limited health literacy HbA1c = 10.4 $\pm$ 2.2, Adequate health literacy HbA1c = 8.6 $\pm$ 1.7, $p < 0.0005$) (13). In addition to health literacy, numeracy skills are also thought to be an important factor to maintain adequate glycemic control. Two studies used numeracy tests. Pulgaron et al found that parental numeracy was related to pediatric glycemic control (-0.34 $p = 0.004$)($r= -0.52$ $p <0.01$) (51). Mulvaney measured adolescent numeracy skills and also found a significant inverse relationship with hemoglobin A1c ($r=-0.291$ $p=0.001$) (50). No studies were identified that investigated parental nutrition literacy and pediatric glycemic control.

Health Literacy and Dental Carries

Dietary intake of sugar, especially in children, can affect oral health and the occurrence of dental carries (52). Early childhood dental carries may also have an association with iron deficiency anemia (53). Dental carries affect approximately 40% of children under the age of 11 (43). It is important to promote adequate oral health early in life because poor oral status later in life is associated with decreased nutritional status as well as other acute and chronic diseases (54). The prevention of dental carries in children requires appropriate dental hygiene practices and knowledge of the sugar content of food.

Five cross sectional studies were identified that investigated the relationship between parental health literacy and the occurrence of pediatric dental carries (29-31, 55, 56). Three studies found inverse associations between parental oral health literacy and child dental health (29, 30, 56). It was found that lower oral health literacy, measured by rapid estimate of adult literacy in dentistry (REALD-30), was related to parental report of their child having poorer dentition (OR=1.44; 95% CI = 1.02. 2.05) (29), higher number of decayed, missing or filled teeth found during oral examination (-0.24 p=0.018) (30), and higher amount of pulp treatments (mean difference REALD-30 Score, pulp treatment =22.1, no pulp treatment = 23.8, p=0.04) (56). However, two other studies had conflicting results. Gong et al investigated pediatric dental health (31) and Vann et al investigated pediatric oral health expenditures (55) both found no significant difference regardless of parental health literacy.

Health Literacy and Nutrition Related Behaviors

Children have unique dietary needs to promote health and an appropriate growth pattern (44). Nutrition and physical activity is a key factor in the prevention of many chronic diseases such as cardiovascular disease (57), diabetes (58) and cancer (59). Developing a nutritious diet and active lifestyle during childhood may help support these behaviors in adulthood. Nutrition knowledge that often precedes healthy diet behaviors has previously been separated into three categories of knowledge "1. an awareness of the importance of nutrition, 2. knowledge of nutrition principles; and 3. 'how-to' knowledge" (23, 60).

Two cross sectional studies were identified that investigated the relationship between health literacy or nutrition and physical activity knowledge and health behaviors of children and parents (27, 61). In an adolescent population, Nelson et al. found that adolescent nutrition and physical activity knowledge, not parental knowledge, was positively associated with adolescent moderate physical activity (0.07, 95% CI 0.01, 0.13) and vigorous physical activity (0.08, 95% CI 0.02, 0.13). Adolescent nutrition and physical activity knowledge was inversely associated with television viewing (-0.07 95% CI -0.12, -0.02) (27). Researchers also found that neither adolescent nor parental nutrition and physical activity knowledge was associated with adolescent consumption of fast food or sugar-sweetened beverages (27). The measure in this study used to estimate knowledge was limited to an evaluation of knowledge related to energy balance that had not been validated in previous research (27).

Yin et al. sought to investigate health literacy of parents of infants to find behaviors that may promote an environment that increases the risk of obesity for the child (61). Parents with lower health literacy, defined as a STOFHLA score indicating inadequate or marginal health literacy, were more likely to report formula feeding (OR 1.8 $p = 0.04$), immediately soothing their crying child by feeding (OR 1.8 $p = 0.01$), propping the bottle while the baby was eating (OR = 1.8 $p = 0.045$) and inadequate activity time for their child (OR = 2.8 $p = 0.004$) (61).

Discussion

A limited amount of research exists that investigates the relationship between child nutritional status and parental health literacy or nutrition literacy. Within the current body of literature, results are varied with some showing poorer pediatric outcomes and other studies showing no significant difference. There are some theories that may explain the variance in results and why health literacy is an important issue to continue to explore.

Gibbs et al. noted that literacy is dependent on the situation and measures of health literacy may not be good measures of nutrition literacy (23). This may explain the variance in results for nutrition related outcomes. Although Nelson et al used a measure of knowledge related to energy balance, this measure has not been validated and did not include questions relating to other facets of nutrition such as comprehension of nutrition labels or macronutrient distribution (27).

It is also important to recognize that at some point during adolescence, children start to take responsibility for making nutrition related decisions. Four studies included in this review assessed parental and child health literacy (26, 48, 50) or nutrition knowledge (27). In these studies child literacy had more significant associations with child nutritional status than parental health literacy (26, 27, 48, 50). This relationship is an important area to investigate in future research.

Although there are validated measures of health literacy (62-64), only some of these measures have been tested for validity within the pediatric population (65, 66). Further, there has not been a study that measures both parental and child health or nutrition literacy while also using a validated measure of dietary intake in the pediatric population. This relationship should be explored in future research studies.

Even if the direct relationship between child health outcome and parental health literacy cannot be drawn, it is still an important issue. The health belief model, a common theory used for planning health interventions, makes the assumption that patients have a basic understanding of health information (67). Without a basic level of health literacy, patients may not accurately perceive disease seriousness, susceptibility or benefits of taking action. This idea is important, especially in the prevention of childhood obesity, because parents with low health literacy are more likely to inaccurately perceive their child's weight status (25).

It is important for health practitioners, including dietitians, to be aware of risk factors for low parental health literacy. Because the majority of Americans have some degree of inadequate health literacy, practitioners should always use written material appropriate for readers with lower literacy. In addition to using appropriate written material, using the teach-back method has been recognized as a beneficial method to minimize miscommunication between health providers and patients (68, 69). Because literacy may be situation specific, dietitians should not assume that patients with higher levels of education have adequate nutrition literacy.

There are many areas within nutrition literacy in which future research could explore. The first step to increase the body of literature in nutrition literacy is to develop a validated measure of nutrition literacy. Research should focus on measuring parental and child health and nutrition literacy to draw relationships with measures of pediatric dietary quality, such as Healthy Eating Index (70). All studies here were of cross sectional design. Future research should include longitudinal designs in order to draw a temporal relationship between health literacy, nutrition literacy, dietary behaviors and nutrition status. Lastly, future research should include interventions to help improve nutrition literacy and evaluate the outcomes of improved nutrition literacy.

Conclusion

From this review of the literature, it is apparent that low health or nutrition literacy is an important consideration when evaluating pediatric nutritional status. Currently there is inadequate evidence to draw a direct relationship between parental health literacy, parental nutrition literacy and pediatric nutritional status. Health professionals, including dietitians, need to be knowledgeable of risk factors for low parental health literacy and nutrition literacy. Practitioners should utilize written educational material at the appropriate reading level and the teach-back method when assisting patients making behavior changes. Future research should focus on interventions to improve nutrition literacy as well as the validation of nutrition literacy measures that can be used in combination with measures of dietary quality.

Chapter 3: Methods

Setting

The study will take place at the University of Kansas Medical Center during a prescheduled appointment time for a study that subjects are already participating in. Data collection will occur from October 2013 through January 2014.

Sample

The sample used for this study will be a convenience sample recruited from participants currently enrolled in University of Kansas HSC #11406 study. Eligible participants for HSC #11406 were women planning to deliver at a hospital in the Kansas City Metropolitan area, additional inclusion and exclusion criteria have been outlined elsewhere (71). For this study, eligible children will be between the ages of 4 and 6 years old. Eligible parents will have English as their primary language. Parent-child dyads will be recruited by being approached during a prescheduled appointment for the participation in HSC #11406 that they are enrolled in. Parents will be asked who the primary person in the household is that purchases food and prepares food that the child eats, parents who state that they are primary or that both parents participate equally will be offered a consent form. Parents who complete the consent form will be included in the study.

Ethics

This ancillary study was approved by the University of Kansas Human Subject Committee (HSC #11406). All subjects enrolled completed informed consent.

Procedures

Data collection occurred from October 2013 through January 2014. Individuals who identified themselves as a parent of a child participating in HSC #11406 who also identified themselves as the primary household food preparer and purchaser were invited to participate. At a standard study visit, subjects were asked to participate while their child was having a cognitive assessment. After consent, the parent had height, weight and nutrition literacy measurements taken. Parents were asked where they get their nutrition information and if they participate in any public assistance food programs such as Supplement Nutrition Assistance Program (SNAP) or the Special Supplemental Program for Women, Infants and Children (WIC). Parents were weighed in kilograms and height in centimeters. Nutrition literacy was measured by a modified version of the Nutrition Literacy Assessment Instrument (40).

The NLAI-P consists of five domains: nutrition and health, food portions, label reading, food groups and consumer skill. Subjects were given the NLAI-P and a pen or pencil to complete the instrument, they were not given a calculator and were asked not to use a calculator on any mobile device they had with them. After subjects completed the NLAI-P they were asked to place it in a manila envelop and seal it so to be assured that results would not impact their child's participation in HSC #11406.

HSC #11406 collects child age, height, weight, parental education, maternal date of birth, socioeconomic status and parental reported 24-hour child dietary recalls. Maternal date of birth was used as a proxy for paternal age. Two 24-hour dietary recalls from each child was entered into Nutrition Data Systems for Research (NDSR) and the combined total of the recalls were used to calculate a HEI-2010 score (70). NDSR has previously been used by Miller et al to calculate Healthy Eating Index-2005 (72). A modified version of the Miller et al. calculation method was used to calculate HEI-2010 for this study. Total score for HEI-2010 has a possible range of 0 – 100. The total score is made up of 9 adequacy components (elements of a diet that are encouraged at higher levels), and 3 moderation components (elements of a diet that are encouraged to consume at lower levels). A HEI-2010 score of 80 or above is considered "good" while 50-80 is "in need of improvement' and less than 50 is "poor".

Analysis of Data

The independent variable, parental NLAI-P score was evaluated by calculating percentage correct in each of the 5 domains of the instrument. The total score was calculated as a straight percentage correct out of 42 and as a weighted percentage correct (giving each domain equal contribution to the total score). Higher scores indicate higher nutrition literacy. Child dietary quality, as measured by HEI-2010, and child BMI percentile are the dependent variables. Cofounding factors are socioeconomic status, parental BMI, and parental education. The relationship between independent and dependent variables were evaluated using Spearman's Rho correlation and linear

regression using the Statistical Package for the Social Sciences (IBM SPSS, release 20.0.0).

Chapter 4: Results

A total of 48 parents were approached and asked to complete the NLAI-P. Of parents who were invited to participate, 95.8% agreed to participate and consented (n=46). Most parents who particpated were female (78.3%). The mean parental age was 33.3 years old. All children were between the ages of 4-6 years and had an average age of 4.93 years (see Table 1).

Table 1: Parental and Child Demographic Characteristics (n=46 dyads)

Parental Characteristics: (n= 46)	
Mean age (SD)	33.3 (4.6)
Gender (%)	78.3 Female, 21.7 Male
Mean BMI (SD)	27.8 (5.43)
Mean estimated income (SD)	52,649 (17,868)
Mean paternal education (SD)	14.5 (2.57)
Mean maternal education (SD)	15.2 (2.65)
Participate in public assistance program (%)	28.2
Child Characteristics:	
Mean Age (SD)	4.93 (0.76)
Gender (%)	45.7 Female, 54.2 Male
Mean BMI Percentile (SD)	61.6 (29.02)

SD: Standard Deviation
%: percentage
BMI: Body Max Index (kg/m^2)

Parental NLAI-P Score

The mean NLAI-P score was 83.6%. Overall, parents demonstrated the highest mean score on the nutrition and health domain (94.6%) and the lowest mean score on the food

portion domain (56.3%). The mean time to complete the NLAI-P was 13 minutes, 7 seconds. Scores for the NLAI-P are represented in Table 2.

Table 2: Scores for the Nutrition Literacy Assessment Instrument for Parents

	Mean	Standard Deviation	Range
Unadjusted total percentage score[1]	83.6	8.71	64.26-97.62
Adjusted percentage score[2]	81.7	9.83	59.24-97.52
Health and Nutrition percent score	94.6	11.15	50-100
Food Portion percent score	56.3	17.23	12.5-87.6
Label Reading percent score	83.0	18.44	42-8-100
Food Groups percent score	95.6	7.74	66.6-100
Consumer Skills percent score	79.3	22.56	33.3-100
Time to complete (minutes:seconds)	13:07	5:04	6-35

[1]Unadjusted total percentage score: Percent correct out of 42 possible questions.
[2]Adjusted percentage score: Percent correct giving each domain equal contribution to the total percent correct.

Child Health Eating Index-2010

The mean child HEI-2010 was 53.5 with scores ranging between 31-86. Most children (58.7%) had a HEI-2010 score between the range of 50-80, indicating a diet in need of improvement. The remainder of children either had poor diet quality (39.1%) or good diet quality (2.2%). Table 3 describes the scoring for HEI-2010.

Correlates with Child Healthy Eating Index-2010

Using Spearman's Rho correlations, there was a significant relationship between parental NLAI-P score and child HEI-2010 ($r= 0.324$, $p= 0.028$) (figure 1). The correlation between child HEI-2010 and the individual domains of the NLAI-P did not reach a level of significance. Higher maternal education level was correlated with higher child HEI-2010 ($r=0.295$, $p=0.047$).

Table 3: Child Healthy Eating Index-2010

	Mean	Standard Deviation	Range	Total Points Possible[1]
Total Score	53.54	14.11	31-86	100
Adequacy Component:				
Total Fruit	3.28	1.34	0-5	5
Whole Fruit	3.478	1.79	0-5	5
Total Vegetables	1.8	1.14	0-5	5
Greens and Beans	0.78	1.54	0-5	5
Whole Grains	5.26	3.12	0-10	10
Dairy	7.22	2.64	1-10	10
Total Protein Foods	3.46	1.22	1-5	5
Seafood and Plant Protein	1.65	2.11	0-5	5
Fatty Acids	4.46	3.28	0-10	10
Moderation Component:				
Refined Grains	6.46	2.93	0-10	10
Sodium	5.46	2.84	0-10	10
Empty Calorie	10.24	5.13	0-20	20

[1] The lowest score for every category is 0 points.

HEI-2010 can further be evaluated using different component scores. Fruit and vegetable consumption (includes whole fruit, total fruit, total vegetable and greens and beans) was not significantly correlated with parental NLAI-P score or any individual domain scores of the NLAI-P. HEI-2010 score for percent empty calories was correlated with higher parental scores on the food portion domain of the NLAI-P ($r=0.341$, $p=0.020$), but did not reach a level of significance in relation to total parental NLAI-P score.

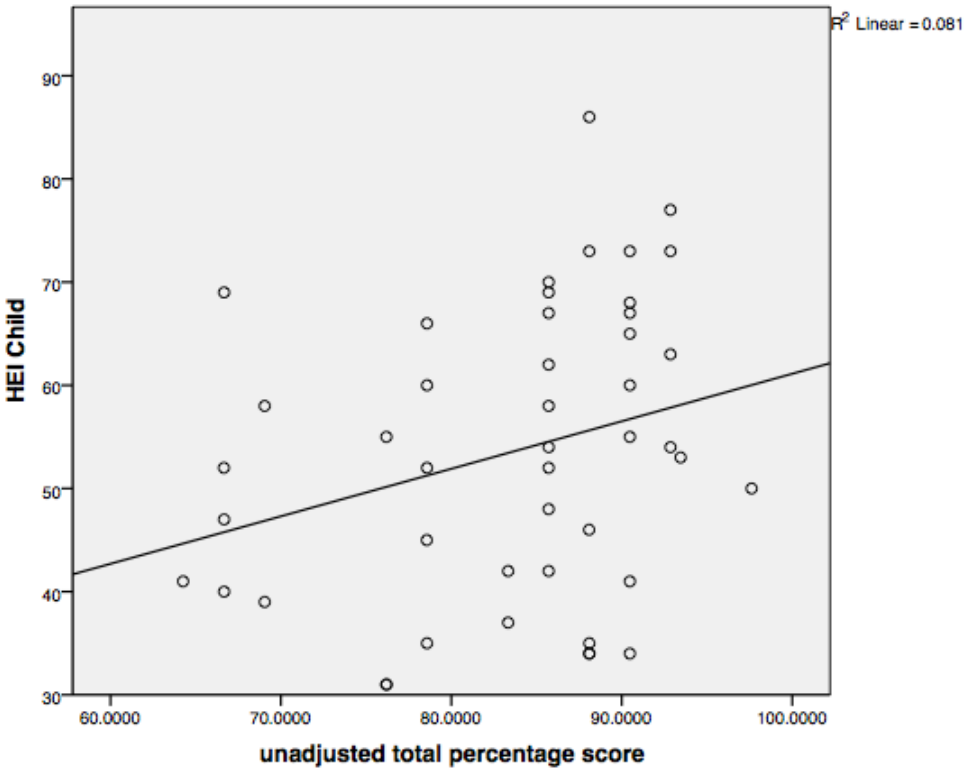

Figure 1: Unadjusted Parental NLAI-P Score in Relation to Child HEI-2010 Score

Correlates with Child Body Mass Index Percentile for Age

Child BMI percentile for age was not correlated with parental NLAI-P score or child HEI-2010 score. However, child BMI percentile for age was positively correlated with parental BMI (r= 0.317, p=0.032) (data not shown).

Correlates with Parental Body Mass Index

Parental BMI was inversely correlated with NLAI-P score (r=-0.456, p= 0.001) (figure 2). In addition, parental BMI was associated with 3 out of the 5 individual domains of the NLAI-P. BMI was inversely related to scores on the domain scores of food groupings (r=-0.383, p= 0.009), consumer skills (r=-0.364, p= 0.013) and label reading (r= -0.356,

p= 0.015).

Parental BMI was inversely correlated with estimated income (r=-0.312, p=0.037) and was positively associated with the number of self reported public assistance food programs in which the family participated (r= 0.473, p= 0.001) (data not shown).

Table 4: Characteristics of Parent-Child Dyads in Relation to Parental Nutrition Literacy Scores

	Parental NLAI-P unadjusted score[1]	Parental NLAI-P adjusted score[2]	Nutrition and health score	Food portion score	Label reading score	Consumer skills score	Food groups score
	----------Spearman's Rho Correlation (p-value)----------						
Parental BMI	**-0.456 (0.001)**	**-0.449 (0.002)**	-0.169 (0.262)	-0.107 (0.480)	**-0.356 (0.015)**	**-0.364 (0.013)**	**-0.383 (0.009)**
Child HEI-2010	**0.324 (0.028)**	**0.295 (0.046)**	0.144 (0.451)	0.281 (0.059)	0.025 (0.870)	0.264 (0.076)	0.160 (0.289)
Child HEI-2010 fruit and vegetable	0.151 (0.318)	0.119 (0.429)	0.261 (0.079)	0.195 (0.195)	-0.073 (0.629)	0.058 (0.704)	0.121 (0.423)
Child HEI-2010 empty calories	0.074 (0.627)	0.040 (0.791)	0.007 (0.964)	**0.341 (0.02)**	-0.167 (0.266)	-0.023 (0.877)	-0.053 (0.726)
Child BMI percentile	-0.122 (0.420)	-0.089 (0.556)	-0.050 (0.739)	0.043 (0.776)	-0.182 (0.225)	-0.040 (0.794)	-0.224 (0.134)

[1]Parental NLAI-P unadjusted score: Percent correct out of 42 possible questions.
[2]Parental NLAI-P adjusted score: Percent correct giving each domain equal contribution to the total percent correct.

Linear Regression

Multiple linear regression analysis was completed for the dependent variables of child HEI-2010, child BMI percentile for age and parental BMI. The only significant linear relationship was between parental BMI and parental unadjusted NLAI-P score (R^2=0.157; p=0.004). For every 1% increase in parental NLAI-P score, parental BMI decreased by 0.26.

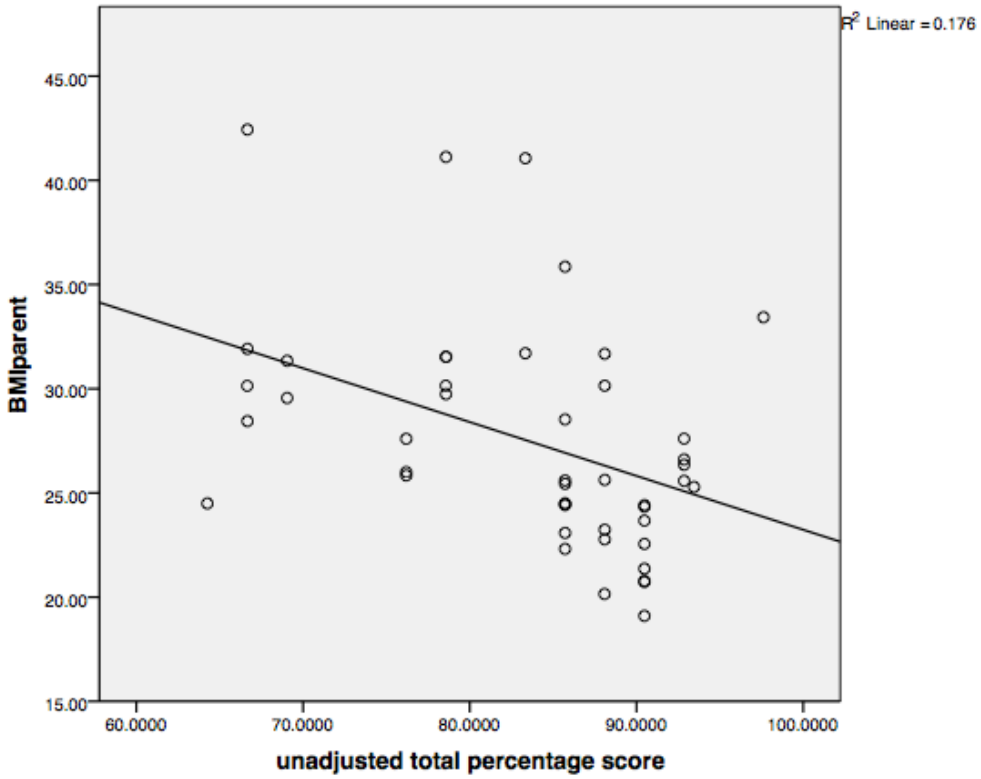

Figure 2: Unadjusted Parental NLAI-P Score in Relation to Parental BMI

Table 5: Linear Regression Model to Predict Parental BMI

Variable	Unit	Intercept	B	Beta	P-value
NLAI-P Unadjusted Score	Percentage	49.065	-0.258	-0.42	0.004

Chapter 5: Discussion

This is the first time that measured parental nutrition literacy has been studied in comparison to diet quality or weight status of children. The results of this study affirm the hypothesis that lower parental nutrition literacy is associated with lower diet quality of a child. However contrary to what was hypothesized, the relationship between

parental nutrition literacy and child weight status did not reach a level of significance.

There was a weak correlation with parental nutrition literacy and child diet quality. There are many factors that may explain why this relationship was not found to be stronger. Nutrition literacy was only measured in one adult who provides food for the child. Many children have multiple adults, such as grandparents, daycare staff or nannies, who provide them with food. We attempted to minimize these outside influences with the inclusion criteria. Parents needed to state that they were the primary food provider of the child and the child needed to be 4-6 years old. Even with these precautions, and though uninvestigated, some children had eating occasions that were not supervised by the parent that completed the NLAI-P. This could imply that there may be inaccuracies in the parental reported 24-hour dietary recalls as well as a reduced impact in the influence of that parent's nutrition literacy skills. Previous research has found inaccuracies in using parents as a proxy for reporting a child's 24-hour dietary intake (73-76).

Past studies (26, 28, 48) have measured health literacy of parents and have not found relationships between parental health literacy and child weight status. It is important to note that of these studies, all 3 used different health literacy measures and studied different age groups making them difficult to compare with each other and with this current study (26, 28, 48). The finding that parental nutrition literacy was not related to child weight status was congruent with these past findings.

Some of the domains and individual questions that make up the NLAI-P are currently undergoing the process of validation. It is possible that some of the items currently

included in this instrument are not strong measures of nutrition literacy. Once non-distinguishing items are removed from the testing instrument, the NLAI-P may become a significant correlate of child weight status. As a measure of nutrition literacy, the NLAI-P does not contain questions related to knowledge or understanding of physical activity recommendations. It is possible that parental physical activity literacy is another factor that influences child weight status.

While it was not a primary focus of this study, correlates of parental BMI were also explored in relation to parental nutrition literacy scores. Although only a moderate correlation was found, out of the factors explored parental BMI had the strongest correlation with parental NLAI-P score. In addition, parental BMI was related to 3 out of the 5 domain scores of the NLAI-P.

In congruence with past studies, parental BMI was associated with child BMI percentile for age (77). Both elevated maternal obesity and childhood obesity are risk factors for the development of adult obesity later in life (78). The relationship among parental nutrition literacy, parental BMI and childhood BMI percentile for age implies that nutrition literacy of parents may be an additional risk factor of the development of adult obesity.

There are limitations to this study. First, this study had a small sample size. As noted earlier, parental nutrition literacy was only measured in one parent. In some families, both parents may participate equally in making nutrition decisions for their child. Future studies should seek to measure both parents' nutrition literacy. In addition to this, although uninvestigated, it was observed that there were often others involved in feeding

the children (e.g. grandparents and day care staff). Parents may not have control or knowledge of what their children are eating in these times. This may also weaken the relationship between parental nutrition literacy and child diet quality. As mentioned previously, this is the first study of this nature and because of that the instrument used to measure nutrition literacy has not been validated. Future research is needed with larger samples size to complete analysis for validation.

Past studies have used measures of parental health literacy and found relationships with child health and nutrition status. Using a measure of nutrition literacy, in comparison to measures of health literacy, provides a better understanding of a person's ability to obtain, process, and understand basic nutrition information (23, 24, 40). Because the primary outcomes were nutrition related, it is a strength of this study that a measure of nutrition literacy was used instead of health literacy.

Another strength of this study is that two 24-hour dietary recalls, obtained within 1-year prior to consent to this study, were used in HEI-2010 analysis. Using two 24-hour dietary recalls, in comparison to only one, is a method used in other studies such as the National Health and Nutrition Examination Survey (79). Height and weight measurements were taken for both parents and children, which is more accurate than self-reported height and weight (80).

Conclusions and Implications

This study shows that the level of nutrition literacy of a parent can both affect their own health as well as their child's health. Lower nutrition literacy of a parent may be a barrier to providing a healthful diet for a child.

Future research should focus on the validation of nutrition literacy instruments. To do so, larger sample sizes are needed for recruitment. Future research should also focus on the development of nutrition literacy instruments for children.

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